FORM PTO-1390 (REV. 12-2001) U S DEPARTMENT OF COMMERCE PATENT AND TRADEMARK OFFICE

TRANSMITTAL LETTER TO THE UNITED STATES DESIGNATED/ELECTED OFFICE (DO/EO/US) CONCERNING A FILING UNDER 35 U.S.C. 371

ATTORNEY 'S DOCKET NUMBER: FUK-89

U S APPLICATION NO (If known, see 37 CFR 1 5): 10/049499

INTERNATIONAL APPLICATION NO.	INTERNATIONAL FILING DATE	PRIORITY DATE CLAIMED
PCT/JP00/05393	August 11, 2000	August 13, 1999

TITLE OF INVENTION: PRODUCING METHOD OF MULTILAYERED PRINTED-CIRCUIT BOARD AND PRODUCING APPARATUS THEREOF

APPLICANT(S) FOR DO/EO/US: Tadahiro OHMI et al.

Applicant herewith submits to the United States Designated/Elected Office (DO/EO/US) the following items and other information

1. [X] This is a **FIRST** submission of items concerning a filing under 35 U.S.C. 371.
2. [ ] This is a **SECOND** or **SUBSEQUENT** submission of items concerning a filing under 35 U.S.C. 371
3. [ ] This is an express request to begin national examination procedures (35 U.S.C. 371(f)). The submission must include items (5), (6), (9) and (21) indicated below.
4. [X] The US has been elected by the expiration of 19 months from the priority date (Article 31).
5. [X] A copy of the International Application as filed (35 U.S.C. 371(c)(2))
   a. [ ] is attached hereto (required only if not communicated by the International Bureau).
   b. [X] has been communicated by the International Bureau.
   c. [ ] is not required, as the application was filed in the United States Receiving Office (RO/US).
6. [X] An English language translation of the International Application as filed (35 U.S.C. 371(c)(2)).
   a. [X] is attached hereto.
   b. [ ] has been previously submitted under 35 U.S.C. 154(d)(4).
7. [X] Amendments to the claims of the International Aplication under PCT Article 19 (35 U.S.C. 371(c)(3))
   a. [ ] are attached hereto (required only if not communicated by the International Bureau).
   b. [ ] have been communicated by the International Bureau.
   c. [ ] have not been made, however, the time limit for making such amendments has NOT expired.
   d. [X] have not been made and will not be made.
8. [ ] An English language translation of the amendments to the claims under PCT Article 19 (35 U.S.C. 371 (c)(3))
9. [X] An oath or declaration of the inventor(s) (35 U.S.C. 371(c)(4)).
10. [ ] An English lanugage translation of the annexes of the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. 371(c)(5)).

Items 11 to 20 below concern document(s) or information included:

11. [ ] An Information Disclosure Statement under 37 CFR 1.97 and 1.98.
12. [ ] An assignment document for recording. A separate cover sheet in compliance with 37 CFR 3.28 and 3.31 is included.
13. [X] A FIRST preliminary amendment.
14. [ ] A SECOND or SUBSEQUENT preliminary amendment.
15. [X] A substitute specification.
16. [ ] A change of power of attorney and/or address letter.
17. [ ] A computer-readable form of the sequence listing in accordance with PCT Rule 13ter.2 and 35 U.S.C. 1.821 - 1.825.
18. [ ] A second copy of the published international application under 35 U.S.C. 154(d)(4).
19. [ ] A second copy of the English language translation of the international application under 35 U.S.C. 154(d)(4).
20. [ ] Other items or information:

U.S. APPLICATION NO (if known, see 37 CFR 1.5)	INTERNATIONAL APPLICATION NO	ATTORNEY'S DOCKET NUMBER
10/049499	PCT/JP00/05393	FUK-89

21. ☒ The following fees are submitted:

BASIC NATIONAL FEE (37 CFR 1.492 (a) (1) - (5)):		CALCULATIONS PTO USE ONLY
Neither international preliminary examination fee (37 CFR 1.482) nor international search fee (37 CFR 1.445(a)(2)) paid to USPTO and International Search Report not prepared by the EPO or JPO	$1040.00	
International preliminary examination fee (37 CFR 1.482) not paid to USPTO but International Search Report prepared by the EPO or JPO	$890.00	
International preliminary examination fee (37 CFR 1.482) not paid to USPTO but international search fee (37 CFR 1.445(a)(2)) paid to USPTO	$740.00	
International preliminary examination fee (37 CFR 1.482) paid to USPTO but all claims did not satisfy provisions of PCT Article 33(1)-(4)	$710.00	
International preliminary examination fee (37 CFR 1.482) paid to USPTO and all claims satisfied provisions of PCT Article 33(1)-(4)	$100.00	
ENTER APPROPRIATE BASIC FEE AMOUNT =		$ 890.00
Surcharge of **$130.00** for furnishing the oath or declaration later than ☐ 20 ☐ 30 months from the earliest claimed priority date (37 CFR 1.492(e)).		$ 0

CLAIMS	NUMBER FILED	NUMBER EXTRA	RATE	
Total claims	7 - 20 =	0	x $18.00	$ 0
Independent claims	3 - 3 =	0	x $84.00	$ 0
MULTIPLE DEPENDENT CLAIM(S) (if applicable)			+ $280.00	$ 0
TOTAL OF ABOVE CALCULATIONS =				$ 890.00
☐ Applicant claims small entity status. See 37 CFR 1.27. The fees indicated above are reduced by 1/2.			+	$ 0
SUBTOTAL =				$ 890.00
Processing fee of **$130.00** for furnishing the English translation later than ☐ 20 ☐ 30 months from the earliest claimed priority date (37 CFR 1.492(f)).				$ 0
TOTAL NATIONAL FEE =				$ 890.00
Fee for recording the enclosed assignment (37 CFR 1.21(h)). The assignment must be accompanied by an appropriate cover sheet (37 CFR 3.28, 3.31). **$40.00** per property +				$ 0
TOTAL FEES ENCLOSED =				$ 890.00
			Amount to be refunded:	$
			charged:	$

a. ☒ A check in the amount of $ 890.00 to cover the above fees is enclosed. Check No. 5893

b. ☐ Please charge my Deposit Account No. _____ in the amount of $ _____ to cover the above fees. A duplicate copy of this sheet is enclosed.

c. ☒ The Commissioner is hereby authorized to charge any additional fees which may be required, or credit any overpayment to Deposit Account No. 501157. A duplicate copy of this sheet is enclosed.

d. ☐ Fees are to be charged to a credit card. **WARNING:** Information on this form may become public. **Credit card information should not be included on this form.** Provide credit card information and authorization on PTO-2038.

NOTE: Where an appropriate time limit under 37 CFR 1.494 or 1.495 has not been met, a petition to revive (37 CFR 1.137 (a) or (b)) must be filed and granted to restore the application to pending status.

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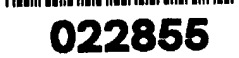

022855

PATENT TRADEMARK OFFICE

SIGNATURE

Randall J. Knuth

NAME

34,644

REGISTRATION NUMBER

Telephone No. 260-485-6001 Facsimile No. 260-486-2794

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re of Applicant Tadahiro OHMI et al. Serial No.: Filing Date: February 12, 2002 Title: PRODUCING METHOD OF MULTILAYERED PRINTED-CIRCUIT BOARD AND PRODUCING APPARATUS THEREOF	)	Art Group: Examiner:

PRELIMINARY AMENDMENT

Hon. Commissioner of Patents and Trademarks
BOX PCT
Washington, D.C. 20231

Sir:

Applicant hereby submits the following Preliminary Amendment.

REMARKS

The undersigned respectfully submits that with this Preliminary Amendment, no new matter has been added.

If the Examiner has any questions or comments that would speed prosecution of this case, the Examiner is invited to call the undersigned at 260/485-6001.

Respectfully submitted,

Randall J. Knuth
Registration No. 34,644

RJK/jrw

Encs: Replacement Claims
Replacement Abstract
Marked-Up Claims
Marked-Up Abstract
Return Postcard

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Date of Deposit February 12, 2002

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Randall J. Knuth, Registration No. 34,644
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(Signature of Person Mailing Paper or Fee)

REPLACEMENT CLAIMS

Please replace Claim 1 with the following:

1. A method of producing a multilayered printed-circuit board, comprising steps of:

stacking up a laminated sheet covered with conductive foil or conductor for an outer layer, a prepreg and a laminated sheet covered with conductor for an inner layer; thereafter,

setting the prepreg by pressurizing/heating; and

before conducting the pressurizing/heating, gas is sprayed on the surfaces of the laminated sheet covered with conductive foil or conductor for the outer layer, a prepreg and a laminated sheet covered with conductor for the inner layer to eliminate impurities from the surfaces.

Please replace Claim 2 with the following:

2. The method according to claim 1, wherein said gas is a dried gas.

Please replace Claim 3 with the following:

3. The method according to claim 2, wherein said dry gas is a heated gas.

Please replace Claim 4 with the following:

4. A method of producing a multilayered printed-circuit board, comprising steps of:

preparing a plurality of wiring boards having a circuit formed with conductive foil, and having through holes filled with a through hole conduct; or

multilayering by pressurizing/heating the plurality of wiring boards each other, and sprayed gas on a surface of the wiring board to eliminate impurities from the wiring board surface before pressurizing/heating.

Please replace Claim 5 with the following:

5. The method according to claim 1, wherein the pressure during said pressurizing step is between 10 to 15 kg/cm^2.

Please replace Claim 6 with the following:

6. A apparatus for producing multilayered printed-circuit board, comprising:

a movable table for laminating and pressurizing molded works each other, and

a means for heating said molded works, wherein the space for pressurizing the molded works is hermetically sealable and the sealable space is provided with an inlet for introducing gas therein and an outlet for discharging the gas.

Please replace Claim 7 with the following:

7. The apparatus according to claim 6, wherein said inlet is disposed in parallel to the laminated face of said molded works.

REPLACEMENT ABSTRACT OF THE DISCLOSURE

Please replace the two paragraphs that make up the ABSTRACT on Page 16 with the following:

The present invention provides a method and apparatus for producing multilayered printed-circuit boards that eliminates resin flow and resolves the problems of board thickness discrepancy and misregistration. A method of producing multilayered printed-circuit boards, comprising the steps of stacking up a laminated sheet covered with conductive foil or conductor for an outer layer, a prepreg, and a laminated sheet covered with conductor for an inner layer and, thereafter, setting the prepreg by pressurizing/heating, wherein, before conducting the pressurizing/heating, gas is conducted to the surface of the laminated sheet covered with conductive foil or conductor for the outer layer, a prepreg and a laminated sheet covered with conductor for the inner layer to eliminate impurities from the surfaces.

Marked-up Claims

WHAT IS CLAIMED IS:

Please amend Claim 1 as follows:

1. A [producing] method of producing a multilayered printed-circuit board, comprising steps of:

stacking up a laminated sheet covered with conductive foil or conductor for an outer layer, a prepreg and a laminated sheet covered with conductor for an inner layer; [and,] thereafter,

setting the prepreg by pressurizing/heating[, wherein,]; and

before conducting the pressurizing/heating, gas is sprayed on the surfaces of the laminated sheet covered with conductive foil or conductor for the outer layer, a prepreg and a laminated sheet covered with conductor for the inner layer to eliminate impurities from the surfaces.

Please amend Claim 2 as follows:

2. The [producing] method [of multilayered printed-circuit board] according to claim 1, wherein said gas is a dried [dry] gas.

Please amend Claim 3 as follows:

3. The [producing] method [of multilayered printed-circuit board] according to claim 2, wherein said dry gas is a heated gas.

Please amend Claim 4 as follows:

4. A [producing] method of producing a multilayered printed-circuit board, comprising steps of:

Marked-up Claims

preparing a plurality of wiring boards having a circuit formed with conductive foil, and having through holes filled with a through hole conduct; or [, and]

multilayering by pressurizing/heating the plurality of wiring boards each other, and sprayed [wherein] gas [is sprayed] on [the] a surface of the wiring board to eliminate impurities from the wiring board surface before pressurizing/heating.

Please amend Claim 5 as follows:

5. The [producing] method [of multilayered printed-circuit board] according to [any one of claims 1 to 4] claim 1, wherein the pressure during said pressurizing step is between 10 to 15 kg/cm^2.

Please amend Claim 6 as follows:

6. A [producing] apparatus [of] for producing multilayered printed-circuit board, comprising:

a movable table for laminating and pressurizing molded works each other, and

a means for heating said molded works, wherein the space for pressurizing the molded works is hermetically [closed] sealable and the [closed] sealable space is provided with an inlet for introducing gas therein and an outlet for discharging the gas.

Please amend Claim 7 as follows:

7. The [producing] apparatus [of multilayered printed-circuit board] according to claim 6, wherein said inlet is

Marked-up Claims

disposed in parallel to the laminated face of said molded [work] works.

Marked-up Abstract

ABSTRACT OF THE DISCLOSURE

The present invention [has an object to provide a producing method and producing apparatus of] provides a method and apparatus for producing multilayered printed-circuit [board] boards that [has eliminated the] eliminates resin flow and [resolved] resolves the problems of board thickness discrepancy and misregistration. A [producing] method of producing multilayered printed-circuit [board] boards, comprising the steps of stacking up a laminated sheet covered with conductive foil or conductor for an outer layer, a prepreg, and a laminated sheet covered with conductor for an inner layer and, thereafter, setting the prepreg by pressurizing/heating, wherein, before conducting the pressurizing/heating, gas is [sprayed] conducted to the surface of the laminated sheet covered with conductive foil or conductor for the outer layer, a prepreg and a laminated sheet covered with conductor for the inner layer to eliminate impurities from the [surface] surfaces.

VERIFICATION OF A TRANSLATION

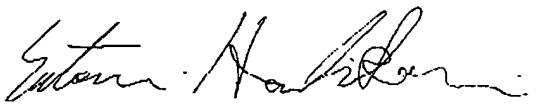
I, the below name translator, hereby declare that:

My name and post office address are as stated below;

That I am knowledgeable in the English language and in the language in which the below identified international application was filed, and that I believed the English translation of the international application PCT/JP00/05393 is a true and complete translation of the above-identified international application as filed.

I hereby declare that all statement made herein of my knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize validity of the application or any patent issued thereon.

Full name of the translator: Satoshi HOSHIKOSHI

Signature of the translator: 

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DESCRIPTION

PRODUCING METHOD OF MULTILAYERED PRINTED-CIRCUIT BOARD AND PRODUCING APPARATUS THEREOF

TECHNICAL FIELD

The present invention concerns a producing method of multilayered printed-circuit board and a producing apparatus thereof, and more particularly a producing method of multilayered printed-circuit board appropriate for preparing a multilayered printed-circuit board appropriate for a package or the like for containing semiconductor devices provided with wiring layers comprising mainly low resistance metals such as copper or through holes conductor filled with metal paste or others on a surface of an insulating layer containing organic resins and a producing apparatus thereof.

BACKGROUND ART

Conventionally, for producing method of multilayered printed-circuit board, a technique comprising the steps of laminating an inner layer material (core material) where a circuit is formed on an dielectric cover and an outer layer material (or conductive foil) through a prepreg, and adhering the inner layer material and the outer layer material by pressurizing and heating them to multilayer is known.

More in detail, the method comprised the following steps:

1. Perforation of a reference hole in the inner layer material
2. Circuit formation by etching (photolitho process) copper foil of the inner layer
3. Black oxide treatment of copper

The black oxide treatment is performed for the purpose of improvement of resin wetting by forming carpet-shape pile through oxidation of the copper foil surface for increasing the adhesion resistance between the copper foil and the prepreg, and more specifically, it is performed by the following steps.

Degreasing → soft etching (roughing chemically the circuit surface of the core material to prepare the board for black oxide treatment) › sulfuric acid washing (having the purpose of removing smut generated by soft etching and rinse) → predep. (common chemical treatment for preventing liquid from dragging in the black oxide treatment tank) → black oxide treatment → drying (remove moisture of black oxide treatment)

4. Laminating press

5. Through hole perforation

6. Through hole inner wall covering

7. Circuit formation by etching of copper foil of outer layer (photolitho process)

8. Shape processing

The laminating press process consists in setting and adhering non set resin of prepreg through pressurizing and heating of blacking treated core material, prepreg and outer layer material (or copper foil).

Conventionally, in the case of using epoxy resin as prepreg, the laminating press process has been carried out under a pressure of 20 to 40 kg/cm^2, temperature equal or superior to 170 °C for 20 minutes or longer.

However, in the conventional producing method mentioned above, there was an inconveniency that the resin flowed in quantity after setting, the board thickness was irregular, and the workability was impeded.

On the other hand, recently, black oxide treatment is required also for the high-integration of the multilayered printed-circuit board. As a technology to cope with such requirement, a so-called blind via hole technology is being developed. This consists in perforating a through hole beforehand (before press lamination) in the insulator board of the inner layer, covering the through hole with copper, or filling the through hole with conductive paste (thermosetting resin mixed with conductive powder) to obtain a through hole conductor. Such

technology is a technology allowing to realize a high black oxide treatment of multilayered printed-circuit board .

However, in the case of applying the aforementioned conventional producing method of multilayered printed-circuit board to such blind via hole technology, there was a problem of inhibiting to cope with the filing because of dislocation between a plurality of layers.

The present invention resolves problems of the aforementioned conventional technology, and has an object to provide a producing method of multilayered printed-circuit board that has eliminated the resin flow and resolved the problems of board thickness discrepancy and misregistration.

Thereby, it has an object of providing a producing method of highly multilayered and highly precise multilayered printed-circuit board and producing apparatus maintaining a good productivity and a high reliability.

The present invention has an object to provide a producing apparatus of multilayered printed-circuit board that has limited the board thickness dispersions, improved the workability and eliminated misregistration.

DISCLOSURE OF INVENTION

The producing method of multilayered printed-circuit board of the present invention comprises steps of stacking up a laminated sheet covered with conductive foil or conductor for outer layer, a prepreg and a laminated sheet covered with conductor for inner layer and, thereafter, setting the prepreg by pressurizing/heating and is characterized by that, before conducting the pressurizing/heating, gas is sprayed to the surface of the laminated sheet covered with conductive foil or conductor for outer layer, a prepreg and a laminated sheet covered with conductor for inner layer to eliminate impurities from the surface.

The producing method of multilayered printed-circuit board of the present invention comprises steps of preparing a plurality of wiring boards having a circuit formed with conductive foil, and having through holes covered with copper or filled with conductive paste, and multilayering by pressurizing/heating the plurality of wiring boards each other, and is characterized by that gas is sprayed to the surface of the wiring board for eliminating impurities from the surface.

The producing apparatus of multilayered printed-circuit board of the present invention comprises a movable table for laminating and pressurizing molded works each other, and means for heating said molded works and, is characterized by that the space for pressurizing the molded works is hermetically closed and the closed space is provided with an inlet for introducing gas therein and an outlet for discharging the gas.

FUNCTION

Now, functions of the present invention shall be described together with findings in the course of achieving the present invention.

In the producing method of multilayered printed-circuit board , the resin flow was important, the discrepancy of board thickness was large, the workability was inhibited, and the misregistration was provoked; however, the Inventor has studied diligently the reason thereof, and found that the reason consists in impurities (especially humidity) remaining on the surface of molded works (outer layer material, conductive foil, inner layer material, prepreg or others).

In short, before the laminating press process, the inner layer material is submitted to the black oxide treatment, which is a wet treatment depositing humidity on the surface. Though humidity was removed by drying (120 °C) after black oxide treatment, the humidity was not removed sufficiently. In addition,

exposure to the atmosphere between drying and laminating press provoked the deposition of humidity.

In the case of laminating press with humidity deposited to the surface of molded works, peeling-off or swelling are provoked.

On the other hand, it was obliged to increase the press pressure in order to laminate all the way maintaining the adhesion force; consequently, a high press pressure as 20 to 40 kg/cm^2 was used.

However, such a high press pressure, increased the resin flow, and provoked various problems.

On the other hand, in case when humidity or other impurities are eliminated, it was found that the adhesion force can be maintained even under a low press pressure.

It may enough to dash gas over the surface of a molded work to eliminate impurities. The space for laminating press is purged by closing and dashing gas in this space, moisture or other impurities are taken away from the surface of a molded work by the gas, and impurities are removed from the surface. The gas is preferable inert (especially argon gas, nitrogen gas). Particularly, the impurity concentration in the gas is preferably equal or inferior to 50 ppb, and more preferably equal or inferior to 10 ppb. The use of such high purity gas allows to prevent impurities from being brought from the gas. The gas pressure may be a normal pressure.

Besides, the gas is dashed preferably in a direction horizontal to the laminating face of the molded work.

Further, it is preferable to heat the molded work when dashing the gas. The heating temperature is preferably 60 to 70 °C. An excessively high temperature sets the prepreg.

BRIEF DESCRIPTION OF DRAWINGS

Fig. 1 is a section of a producing apparatus of multilayered printed-circuit board according to an embodiment of the present invention;

Fig. 2 is a flow chart showing steps of a producing method of multilayered printed-circuit board according to an example of the present invention; and

Fig. 3 is a section showing steps of the producing method of multilayered printed-circuit board according to the example of the present invention.

(Description of Symbols)

2a, 2b Die (cover)

3a, 3b Stainless board

4a, 4b Laminated sheet covered with copper for outer layer

5 Prepreg

6 Laminated sheet covered with copper for inner layer

7a, 7b Heater or heating by heat transfer oil

9 Outlet

10 Inlet

11 Space

13 Gas (gas)

14 Heater

15 Gas supply pipe.

BEST MODE OF CARRING OUT THE INVENTION

(Laminated sheet covered with electric conductor for inner layer)

The laminated sheet covered with electric conductor for inner layer is an inner layer material and, here, the inner layer includes signal layer, power

supply layer, ground layer or other conductive patterns placed inside the board other than conductive patterns placed in the outsides which are surface or back outer layers of a multilayered printed-wiring board.

Conductors include generally copper or copper alloys. As other conductors, for example, silver, aluminum, gold or alloys containing one or more of them, and, Ni-Cr alloy or the like are used.

It is preferable to apply the inner layer circuit surface treatment to the inner layer. The inner layer circuit surface treatment is a surface treatment for creating a fine relief on the conductor surface in order to improve the adhesion force of the inner layer circuit. Black oxide treatment, copper oxide reduction method, micro-etching method, electroless method and DT (double treatment) cooper foil or others can be enumerated.

As base member (inner layer material) for covering electric conductors composing a laminated sheet, thermosetting resins such as epoxy resin, polyimide resin or other resins, laminated sheet impregnating glass with them, aluminum nitride, silicon carbide, alumina or other ceramics are used.

(Laminated sheet covered with electric conductor for outer layer)

The outer layer is a layer of conductor patterns on both faces of a multilayered printed-wiring board.

The electric conductor is similar to the laminated sheet covered with electric conductor for inner layer.

An electric conductor foil may be used in place of laminated sheet covered with electric conductor for outer layer.

(Prepreg)

It is an adhesion sheet made into a half set B stage state by impregnating a glass cloth of reinforcing material with a thermosetting resin.

As thermosetting resin, phenol resin, epoxy resin, polyimide resin, altered polyimide resin, urea resin, melamine resin, silicone resin, polyurethane resin. non saturated polyester resin, aril resin or others can be cited.

Besides, filler can be combined with them in order to increase the strength of the wiring board.

(Through hole)

In case of forming a through hole after the laminating press, perforation may be performed by a drill or the like and then, the inner wall of the through hole may be covered.

In case of via hole, the perforation is performed in the prepreg by a publicly known method such as drill, punching, sandblast, laser or others.

Then, the hole inside is covered with copper or filled with electric conductor paste. The electric conductor paste is prepared by kneading an electric conductor powder and a binder made of thermal conductive resin. As electric conductor, copper, silver, aluminum or other metals are used. As thermosetting resin, those mentioned above may be used.

The hole inside is filled with a sufficient quantity of electric conductive paste, the electric conductive paste is set, and flushed by polishing or the like.

As through hole, holes of 30 μm in diameter may be opened with an interval of 30 μm.

While the gap of through hole conductor was as large as 150 μm in the related art, as it is possible to reduce the gap of through hole conductor to $\pm$ 20 μm in the present invention, no connection deficiency appears even for diameter 50 μm and interval 50 μm.

(Impurity elimination)

In the present invention, impurities, mainly moisture, are removed from the surface of the molded work, before performing the laminating press. The

molded work is placed in the space for laminating press before removing impurities. In short, after arrangement in the space, impurities are removed from the surface of the molded work by dashing gas of high purity in the space and purging the space. Purge time and frequency are not necessarily evident; however, the relation between time/frequency and moisture elimination quantity may be determined beforehand by experiment using a real press machine, and they may be decided based on the results thereof.

It should be appreciated that is it important to eliminate impurities just before performing the press lamination. Because, even if moisture is removed out of the space for performing the laminating press, impurities such as moisture deposit instantaneously on the surface of a molded work if the same is exposed to the atmosphere during the ulterior transport to the space for performing the laminating press. It is the case even in a clean room. Nonetheless, the effect of the present invention can be achieved similarly in the case of eliminating impurities outside the space for press lamination and, thereafter, the molded work is contained in a transport box or the like whose inside is isolated from the atmosphere, and transported to the space for press lamination.

As gas, a dry gas not containing moisture is preferable. Besides, it is preferable to use a heated gas. As for gas temperature, 60 to 70 °C is preferable.

It should be appreciated that it is necessary to arrange disposing interstices between molded works each other in order to eliminate impurities in the space for performing the laminating press and, for instance, a hand holding the molded work at the corner section or side face of the molded work may be provided in an advanceable /retractable state. The molded work floats in a state placed on the hand, gas is dashed in this state to remove impurities, and after

impurity elimination, the hand is retracted, and molded works are laminated each other before performing the press lamination.

(Press Lamination)

In the present invention, as pressurizing pressure for performing the press lamination, a pressure less than the related art, 15 kg/cm^2 is used preferably. A multilayered printed-circuit board of good adhesion without swelling can be obtained even under such a low pressure.

The press lamination may be performed by any of pin lamination method, mass lamination method, or sequential lamination method.

(Laminating apparatus)

Fig. 1 shows a producing apparatus of multilayered printed-circuit board according to an embodiment of the present invention.

The apparatus comprises die covers 2a, 2b for laminating and pressurizing molded works (laminated sheet covered with copper for outer layer 4a, 4b, laminated sheet covered with copper for inner layer 6) each other, and means for heating the molded works 4a, 4b, 6 (heater 7a, 7b), a space 11 for pressurizing the molded works 4a, 4b, 6 is closed and, at the same time, the closed space 11 is provided with an inlet 10 for introducing gas 13 therein and an outlet 9 for discharging the gas.

In this example, the inlet 10 is disposed at two points, and arranged to dash the gas in parallel with the laminated surface of the molded works 4a, 4b, 6. Two or more inlets 10 may be installed. Besides, a heater 14 for heating the gas is disposed in the middle of gas supply pipe 15.

On the other hand, the outlet 9 is disposed at an opposed position across the inlet 10 and the space 11. Consequently, the gas convection is reduced, and impurities are removed more efficiently.

Examples

(Example 1)

Laminated sheets covered with copper for outer layer 4a, 4b, a laminated sheet covered with copper for outer layer 6 and a prepreg 5 as glue were prepared, stacked and perforated with a reference hole.

In this example, epoxy resin was used for the outer layer material of the laminated sheet covered with copper for outer layer 4a, 4b and for the inner layer material of the laminated sheet covered with copper for inner layer 6. Also, as prepreg, a glass cloth impregnated with epoxy resin was used.

After perforating the reference hole, only the laminated sheet covered with copper for inner layer 6 was taken out, and an inner layer pattern based on the design was formed.

Then, the copper foil surface of the inner layer pattern was covered with black oxide as roughening treatment.

The prepreg was put between the laminated sheet covered with copper for inner layer 6 and the laminated sheet covered with copper for outer layer 4a, 4b.

However, an interstice was provided between the laminated sheets covered with copper for outer layer 4a, 4b, laminated sheet covered with copper for outer layer 6 and prepreg 5 and gas introduced into the space 11 from the inlet 10 and heated to 70 °C circulated in parallel to the laminated face. It should be appreciated that, for instance, the corner section of the sheet may made supportable by a point, in order to dispose a space between the laminated sheets covered with copper for outer layer, laminated sheet covered with copper for outer layer and prepreg.

A guide pin was passed through the reference hole opened in the previous step, and a relative misregistration among respective layer conductor patterns.

They are pressed by stainless board 3a, 3b and press laminated. The temperature was 170 °C, time 30 min and pressure 15 kg/cm^2.

The quantity of resin forced out from the board end after the press lamination was measured to obtain 1 mm or less.

Next, copper of the outer layer was etched by a publicly known method, to form a wiring pattern.

The following tests were carried out for the multilayered printed-circuit board prepared as mentioned above. In short, the multilayered printed-circuit board was boiled for four (4) hours, dipped in a solder of 260 °C for 20 sec, and exfoliation and swelling were observed.

As the result, no exfoliation and swelling were remarked.

It should be appreciated that, in the case of setting the pressurizing pressure to 10 kg/cm^2, similarly, no exfoliation and swelling were remarked, but in the case of setting to 8 kg/cm^2, a slight swelling was observed.

(Example 2)

In this example, the lamination was carried out by a sequential lamination method lamination method as shown in Fig. 2.

In this example also, the quantity of forced out resin was 1 mm or less between respective layers.

In addition, no exfoliation and swelling were remarked.

(Example 3)

In this example, a through hole 21 of 50 μm in diameter was formed in a laminated sheet of epoxy resin covered with copper (thickness 80 μm) and filled with a copper paste 22 made of copper powder and cellulose and dried.

Moreover, a circuit pattern 23 was formed on the laminated sheet covered with copper 20 by a publicly known method, to obtain a single wiring board 24 (Fig. 3 (d)).

Single circuit boards 24a, 24b are produced according to the same procedures as the above.

Three (3) single wiring boards 24a. 24b. 24c and a prepreg were disposed in the producing apparatus of multilayered printed-circuit board shown in Fig. 1, and an argon gas of 10 ppb or less in impurity concentration was dashed into the space 11. The temperature of argon gas was set to 70 °C.

Next, dies 2a, 2b were heated to 170 °C, and compressed by a pressurizing pressure 15 kg/cm^2. Exfoliation and swelling were observed as in the example 1, and no exfoliation and swelling were remarked.

On the other hand, deformation and misregistration of through hole conductor were measured, to find the misregistration to be 20 μm or less.

INDUSTRIAL APPLICABILITY

According to the present invention, a multilayered printed-circuit board exempt of exfoliation and swelling and presenting considerably less misregistration of through hole conductor than the prior art can be produced.

CLAIMS

1. A producing method of multilayered printed-circuit board, comprising steps of stacking up a laminated sheet covered with conductive foil or conductor for outer layer, a prepreg and a laminated sheet covered with conductor for inner layer and, thereafter, setting the prepreg by pressurizing/heating, wherein, before conducting the pressurizing/heating, gas is sprayed on the surfaces of the laminated sheet covered with conductive foil or conductor for outer layer, a prepreg and a laminated sheet covered with conductor for inner layer to eliminate impurities from the surfaces.

2. The producing method of multilayered printed-circuit board according to claim 1, wherein said gas is dry gas.

3. The producing method of multilayered printed-circuit board according to claim 2, wherein said dry gas is heated gas.

4. A producing method of multilayered printed-circuit board, comprising steps of preparing a plurality of wiring boards having a circuit formed with conductive foil, and having through holes filled with through hole conduct, and multilayering by pressurizing/heating the plurality of wiring boards each other, wherein gas is sprayed on the surface of the wiring board to eliminate impurities from the surface before pressurizing/heating.

5. The producing method of multilayered printed-circuit board according to any one of claims 1 to 4, wherein the pressure during said pressurizing is 10 to 15 kg/cm^2.

6. A producing apparatus of multilayered printed-circuit board, comprising a movable table for laminating and pressurizing molded works each other, and a means for heating said molded works, wherein the space for pressurizing the molded works is hermetically closed and the closed space is

provided with an inlet for introducing gas therein and an outlet for discharging the gas.

7. The producing apparatus of multilayered printed-circuit board according to claim 6, wherein said inlet is disposed in parallel to the laminated face of said molded work.

ABSTRACT

The present invention has an object to provide a producing method and producing apparatus of multilayered printed-circuit board that has eliminated the resin flow and resolved the problems of board thickness discrepancy and misregistration.

A producing method of multilayered printed-circuit board , comprising steps of stacking up a laminated sheet covered with conductive foil or conductor for outer layer, a prepreg and a laminated sheet covered with conductor for inner layer and, thereafter, setting the prepreg by pressurizing/heating, wherein, before conducting the pressurizing/heating, gas is sprayed to the surface of the laminated sheet covered with conductive foil or conductor for outer layer, a prepreg and a laminated sheet covered with conductor for inner layer to eliminate impurities from the surface.

3/prts

Substitute Specification

Tadahiro OHMI
Hidetoshi MURAKAMI

PRODUCING METHOD OF MULTILAYERED PRINTED-CIRCUIT BOARD AND PRODUCING APPARATUS THEREOF

BACKGROUND OF THE SPECIFICATION

1. Field of the invention.

The present invention concerns a method of producing multilayered printed-circuit boards and a producing apparatus thereof, and more particularly a method of producing multilayered printed-circuit boards appropriate for preparing a multilayered printed-circuit board appropriate for a package containing semiconductor devices provided with wiring layers comprising mainly of low resistance metals such as copper or through hole conductors filled with metal paste or others material on a surface of an insulating layer containing organic resins and an apparatus for producing same.

2. Background of the related art.

Conventionally, a method for producing multilayered printed-circuit boards, a technique is utilized comprising the steps of laminating an inner layer material (core material) where a circuit is formed on an dielectric cover and an outer layer material (or conductive foil) through a prepreg, and adhering the inner layer material and the outer layer material by pressurizing and heating them to multilayer.

More in detail, the method comprised the following steps:

1. Perforation of a reference hole in the inner layer material

2. Circuit formation by etching (photolitho process) a copper foil of the inner layer

3. Black oxide treatment of the copper

The black oxide treatment is performed for the purpose of improvement of resin wetting by forming carpet-shaped pile through oxidation of the copper foil surface for increasing the adhesion resistance between the copper foil and the prepreg, and more specifically, it is performed by the following steps.

Degreasing is followed by soft etching (e.g., chemically roughing the circuit surface of the core material to prepare the board for black oxide treatment) then followed by sulfuric acid washing (having the purpose of removing debris generated by soft etching and rinse) then predep. (a common chemical treatment for preventing liquid from dragging in the black oxide treatment tank) then black oxide treatment then drying (to remove moisture of black oxide treatment).

4. Laminating press

5. Through hole perforation

6. Through hole inner wall covering

7. Circuit formation by etching of copper foil of outer layer (photolitho process)

8. Shape processing

The laminating press process consists in setting and adhering a non-set resin of the prepreg through pressurizing and heating of blacking treated core material, prepreg and outer layer material (or copper foil).

Conventionally, in the case of using epoxy resin as prepreg, the laminating press process has been carried out under a pressure of 20 to 40 kg/cm^2, temperature equal or superior to 170°C for 20 minutes or longer.

However, in the conventional producing method mentioned above, there was an inconveniency that the resin flowed in quantity after setting, the board thickness was irregular, and the workability was impeded.

On the other hand, recently, black oxide treatment is required also for the high-integration of the multilayered printed-circuit board. As a technology to cope with such requirement, a so-called blind hole technology is being developed. This consists in perforating a through hole beforehand (before press lamination) in the insulator board of the inner layer, covering the through hole with copper, or filling the through hole with conductive paste (thermosetting resin mixed with conductive powder) to obtain a through hole conductor. Such technology is a technology allowing to realize a high black oxide treatment of multilayered printed-circuit board.

However, in the case of applying the aforementioned conventional producing method of multilayered printed-circuit board to such blind hole technology, there was a problem of inhibiting to cope with the filing because of dislocation between a plurality of layers.

The present invention resolves problems of the aforementioned conventional technology, and has an object to

provide a method of producing multilayered printed-circuit board that has eliminated the resin flow and resolved the problems of board thickness discrepancy and misregistration.

Thereby, it has an object of providing a method of producing highly multilayered and highly precise multilayered printed-circuit boards and producing apparatus maintaining a good productivity and a high reliability.

The present invention has an object to provide an apparatus of producing multilayered printed-circuit board that has limited the board thickness dispersions, improved the workability and eliminated misregistration.

SUMMARY OF THE INVENTION

The method of producing multilayered printed-circuit boards of the present invention comprises steps of stacking up a laminated sheet covered with conductive foil or a conductor for outer layer, a prepreg and a laminated sheet covered with a conductor for an inner layer and, thereafter, setting the prepreg by pressurizing/heating and is characterized by that, before conducting the pressurizing/heating, gas or fluid is sprayed to the surface of the laminated sheet covered with conductive foil or the conductor for the outer layer, a prepreg and a laminated sheet covered with conductor for the inner layer to eliminate impurities from the surface.

The method of producing multilayered printed-circuit boards of the present invention comprises steps of preparing a plurality of wiring boards having a circuit formed with conductive foil,

and having through holes covered with copper or filled with conductive paste, and multilayering by pressurizing/heating the plurality of wiring boards each other, and is characterized by that gas is sprayed to the surface of the wiring board for eliminating impurities from the surface.

The apparatus for producing multilayered printed-circuit board of the present invention comprises a movable table for laminating and pressurizing molded works each other, and means for heating said molded works and, is characterized by that the space for pressurizing the molded works is hermetically closed and the closed space is provided with an inlet for introducing gas therein and an outlet for discharging the gas.

FUNCTION

Now, functions of the present invention shall be described together with findings in the course of achieving the present invention.

In the method of producing multilayered printed-circuit boards, the resin flow was important, the discrepancy of board thickness was large, the workability was inhibited, and the misregistration was provoked; however, the Inventor has studied diligently the reason thereof, and found that the reason consists in impurities (especially humidity) remaining on the surface of molded works (e.g., outer layer material, conductive foil, inner layer material, prepreg or others).

In short, before the laminating press process, the inner layer material is submitted to the black oxide treatment, which

is a wet treatment depositing humidity on the surface. Though humidity was removed by drying (120°C) after black oxide treatment, the humidity was not removed sufficiently. In addition, exposure to the atmosphere between drying and laminating press provoked the deposition of humidity.

In the case of a laminating press with humidity deposited to the surface of molded works, peeling-off or swelling are provoked.

On the other hand, it was obliged to increase the press pressure in order to laminate completely while maintaining the adhesion force; consequently, a high press pressure as 20 to 40 kg/cm^2 was used.

However, such a high press pressure, increased the resin flow, and provoked various problems.

On the other hand, in case when humidity or other impurities are eliminated, it was found that the adhesion force can be maintained even under a low press pressure.

It may enough to flow gas over the surface of a molded work to eliminate impurities. The compression space for the laminating press is purged by closing and flowing gas in this space, moisture or other impurities are taken away from the surface of a molded work by the gas, and impurities are removed from the surface. The gas is preferable inert (preferably argon gas, nitrogen gas). Particularly, the impurity concentration in the gas is preferably equal or less than 50 ppb, and more preferably equal or less than 10 ppb. The use of such high

purity gas allows to prevent impurities from being brought from the gas. The gas pressure may be a normal pressure.

Besides, the gas is flowed preferably in a direction horizontal to the laminating face of the molded work.

Further, it is preferable to heat the molded work when flowing the gas. The heating temperature is preferably 60°C to 70°C. An excessively high temperature sets the prepreg.

BRIEF DESCRIPTION OF DRAWINGS

The above-mentioned and other features and advantages of this invention, and the manner of attaining them, will become more apparent and the invention will be better understood by reference to the following description of an embodiment of the invention taken in conjunction with the accompanying drawings, wherein:

Fig. 1 is a section of an apparatus producing multilayered printed-circuit boards according to an embodiment of the present invention;

Fig. 2 is a flow chart showing steps of a method producing multilayered printed-circuit board according to an example of the present invention; and

Fig. 3 is a section showing steps of the producing method of multilayered printed-circuit board according to the example of the present invention.

Corresponding reference characters indicate corresponding parts throughout the several views. The exemplification set out herein illustrates one preferred embodiment of the invention, in

one form, and such exemplification is not to be construed as limiting the scope of the invention in any manner.

Description of Symbols

2a, 2b	Die (cover)
3a, 3b	Stainless board
4a, 4b	Laminated sheet covered with copper for outer layer
5	Prepreg
6	Laminated sheet covered with copper for inner layer
7a, 7b	Heater or heating by heat transfer oil
9	Outlet
10	Inlet
11	Space
13	Gas (gas)
14	Heater
15	Gas supply pipe.

DETAILED DESCRIPTION OF THE INVENTION

Best Mode of Carrying out the Invention

(Laminated sheet covered with electric conductor for inner layer)

The laminated sheet covered with an electric conductor for the inner layer is an inner layer material and, here, the inner layer includes a signal layer, power supply layer, ground layer or other conductive patterns placed inside the board other than conductive patterns placed in the outsides which are the surface or back outer layers of a multilayered printed-wiring board.

Conductors include generally copper or copper alloys. As other conductors, for example, silver, aluminum, gold or alloys containing one or more of them, and, Ni-Cr alloy or the like are used.

It is preferable to apply the inner layer circuit surface treatment to the inner layer. The inner layer circuit surface treatment is a surface treatment for creating a fine relief on the conductor surface in order to improve the adhesion force of the inner layer circuit. Black oxide treatment, copper oxide reduction method, micro-etching method, electroless method and DT (double treatment) cooper foil or others can be enumerated.

As a base member (inner layer material) for covering electric conductors composing a laminated sheet, thermosetting resins such as epoxy resin, polyimide resin or other resins, laminated sheets having impregnating glass with them, aluminum nitride, silicon carbide, alumina or other ceramics are used.

(Laminated sheet covered with electric conductor for outer layer)

The outer layer is a layer of conductor patterns on both faces of a multilayered printed-wiring board.

The electric conductor is similar to the laminated sheet covered with electric conductor for inner layer.

An electric conductor foil may be used in place of a laminated sheet covered with electric conductor for an outer layer.

(Prepreg)

Prepreg is an adhesion sheet made into a half set B stage state by impregnating a glass cloth of reinforcing material with a thermosetting resin.

As thermosetting resin, phenol resin, epoxy resin, polyimide resin, altered polyimide resin, urea resin, melamine resin, silicone resin, polyurethane resin, non saturated polyester resin, aril resin or others can be cited.

Also, fillers can be combined with them in order to increase the strength of the wiring board.

(Through hole)

In case of forming a through hole after the laminating press, perforation may be performed by a drill or the like and then, the inner wall of the through hole may be covered or coated.

In case of a via hole, the perforation is performed in the prepreg by a publicly known method such as drill, punching, sandblast, laser or others.

Then, the hole inside is covered with copper or filled with electric conductor paste. The electric conductor paste is prepared by kneading an electric conductor powder and a binder made of thermal conductive resin. As an electric conductor, copper, silver, aluminum or other metals are used. As thermosetting resin, those mentioned above may be used.

The hole inside is filled with a sufficient quantity of electric conductive paste, the electric conductive paste is set, and flushed by polishing or the like.

As a through hole, holes of 30 μm in diameter may be opened with an interval of 30 μm.

While the gap of through hole conductor was as large as 150 μm in the related art, as it is possible to reduce the gap of through hole conductor to ± 20 μm in the present invention, no connection deficiency appears even for diameter 50 μm and interval 50 μm.

(Impurity elimination)

In the present invention, impurities, mainly moisture, are removed from the surface of the molded work, before performing on the laminating press. The molded work is placed in the space for laminating before removing impurities. In short, after arrangement in the space, impurities are removed from the surface of the molded work by flowing gas of high purity in the space and purging the space. Purge time and frequency are not necessarily evident; however, the relation between time/frequency and moisture elimination quantity may be determined beforehand by experiment using a real press machine, and they may be decided based on the results thereof.

It should be appreciated that is it important to eliminate impurities just before performing the press lamination. Because, even if moisture is removed out of the space for performing the laminating press, impurities such as moisture deposit

instantaneously on the surface of a molded work if the same is exposed to the atmosphere during the ulterior transport to the space for performing the laminating press. It is the case even in a clean room. Nonetheless, the effect of the present invention can be achieved similarly in the case of eliminating impurities outside the space for press lamination and, thereafter, the molded work is contained in a transport box or the like whose inside is isolated from the atmosphere, and transported to the space for press lamination.

As gas, a dry gas not containing moisture is preferable. Besides, it is preferable to use a heated gas. As for gas temperature, 60°C to 70°C is preferable.

It should be appreciated that it is necessary to arrange disposing interstices between molded works in order to eliminate impurities in the space for performing the laminating press and, for instance, a hand for holding the molded work at the corner section or side face of the molded work may be provided in an advanceable /retractable state. The molded work, floats in a state placed on the hand, then gas is flowed in this state to remove impurities, and after impurity elimination, the hand is retracted, and molded works are laminated to each other before performing the press lamination.

(Press Lamination)

In the present invention, as pressurizing pressure for performing the press lamination, a pressure less than the related art, 15 kg/cm^2 is used preferably. A multilayered printed-

circuit board with good adhesion without swelling can be obtained even under such a low pressure.

The press lamination may be performed by any of pin lamination method, mass lamination method, or sequential lamination method.

(Laminating apparatus)

Fig. 1 shows a producing apparatus of multilayered printed-circuit board according to an embodiment of the present invention.

The apparatus comprises die covers 2a, 2b for laminating and pressurizing the molded works (for example, laminated sheets covered with copper for outer layer 4a, 4b, laminated sheets covered with copper for inner layer 6), each other, and means for heating the molded works 4a, 4b, 6 (heater 7a, 7b). A space 11 for pressurizing the molded works 4a, 4b, 6 is closed and, at the same time, the closed space 11 is provided with an inlet 10 for introducing gas 13 therein and an outlet 9 for discharging the gas.

In this example, the inlet 10 is disposed at two points, and arranged to flow the gas in parallel with the laminated surface of the molded works 4a, 4b, 6. Two or more inlets 10 may be installed. Besides, a heater 14 for heating the gas is disposed in the middle of gas supply pipe 15.

On the other hand, the outlet 9 is disposed at an opposed position across the inlet 10 and the space 11. Consequently, the

gas convection is reduced, and impurities are removed more efficiently.

Examples

(Example 1)

Laminated sheets covered with copper for outer layer 4a, 4b, a laminated sheet covered with copper for outer layer 6 and a prepreg 5 as glue were prepared, stacked and perforated with a reference hole.

In this example, epoxy resin was used for the outer layer material of the laminated sheet covered with copper for outer layer 4a, 4b and for the inner layer material of the laminated sheet covered with copper for inner layer 6. Also, as prepreg, a glass cloth impregnated with epoxy resin was used.

After perforating the reference hole, only the laminated sheet covered with copper for inner layer 6 was taken out, and an inner layer pattern based on the design was formed.

Then, the copper foil surface of the inner layer pattern was covered with black oxide as a roughening treatment.

The prepreg was put between the laminated sheet covered with copper for inner layer 6 and the laminated sheet covered with copper for outer layer 4a, 4b.

However, an interstice was provided between the laminated sheets covered with copper for outer layer 4a, 4b, laminated sheet covered with copper for outer layer 6 and prepreg 5 and gas introduced into the space 11 from the inlet 10 and heated to 70°C circulated in parallel to the laminated face. It should be

appreciated that, for instance, the corner section of the sheet may made supportable by a point, in order to dispose a space between the laminated sheets covered with copper for outer layer, laminated sheet covered with copper for outer layer and prepreg to the gas.

A guide pin was passed through the reference hole opened in the previous step, and a relative misregistration among respective layer conductor patterns is prevented.

They (the lamination) are pressed by stainless steel board 3a, 3b and press laminated. The temperature was 170°C, time 30 min and pressure 15 kg/cm^2.

The quantity of resin forced out from the board end after the press lamination was measured to obtain 1 mm or less.

Next, copper of the outer layer was etched by a publicly known method, to form a wiring pattern.

The following tests were carried out for the multilayered printed-circuit board prepared as mentioned above. In short, the multilayered printed-circuit board was boiled for four (4) hours, dipped in a solder of 260°C for 20 sec, and exfoliation and swelling were observed.

As the result of the test, no exfoliation and swelling were observed.

It should be appreciated that, in the case of setting the pressurizing pressure to 10 kg/cm^2, similarly, no exfoliation and swelling were observed, but in the case of setting to 8 kg/cm^2, a slight swelling was observed.

(Example 2)

In this example, the lamination was carried out by a sequential lamination method lamination method as shown in Fig. 2.

In this example also, the quantity of forced out resin was 1 mm or less between respective layers.

In addition, no exfoliation and swelling were observed.

(Example 3)

In this example, a through hole 21 of 50 μm in diameter was formed in a laminated sheet of epoxy resin covered with copper (thickness 80 μm) and filled with a copper paste 22 made of copper powder and cellulose, and dried.

Moreover, a circuit pattern 23 was formed on the laminated sheet covered with copper 20 by a publicly known method, to obtain a single wiring board 24 (Fig. 3 (d)).

Single circuit boards 24a, 24b are produced according to the same procedures as the above.

Three (3) single wiring boards 24a, 24b, 24c and a prepreg were disposed in the apparatus producing a multilayered printed-circuit board shown in Fig. 1, and an argon gas of 10 ppb or less in impurity concentration was flowed into the space 11. The temperature of argon gas was set to 70°C.

Next, dies 2a, 2b were heated to 170°C, and compressed by a pressurizing pressure 15 kg/cm^2. The exfoliation and swelling test was conducted as in the example 1, and no exfoliation and swelling was observed.

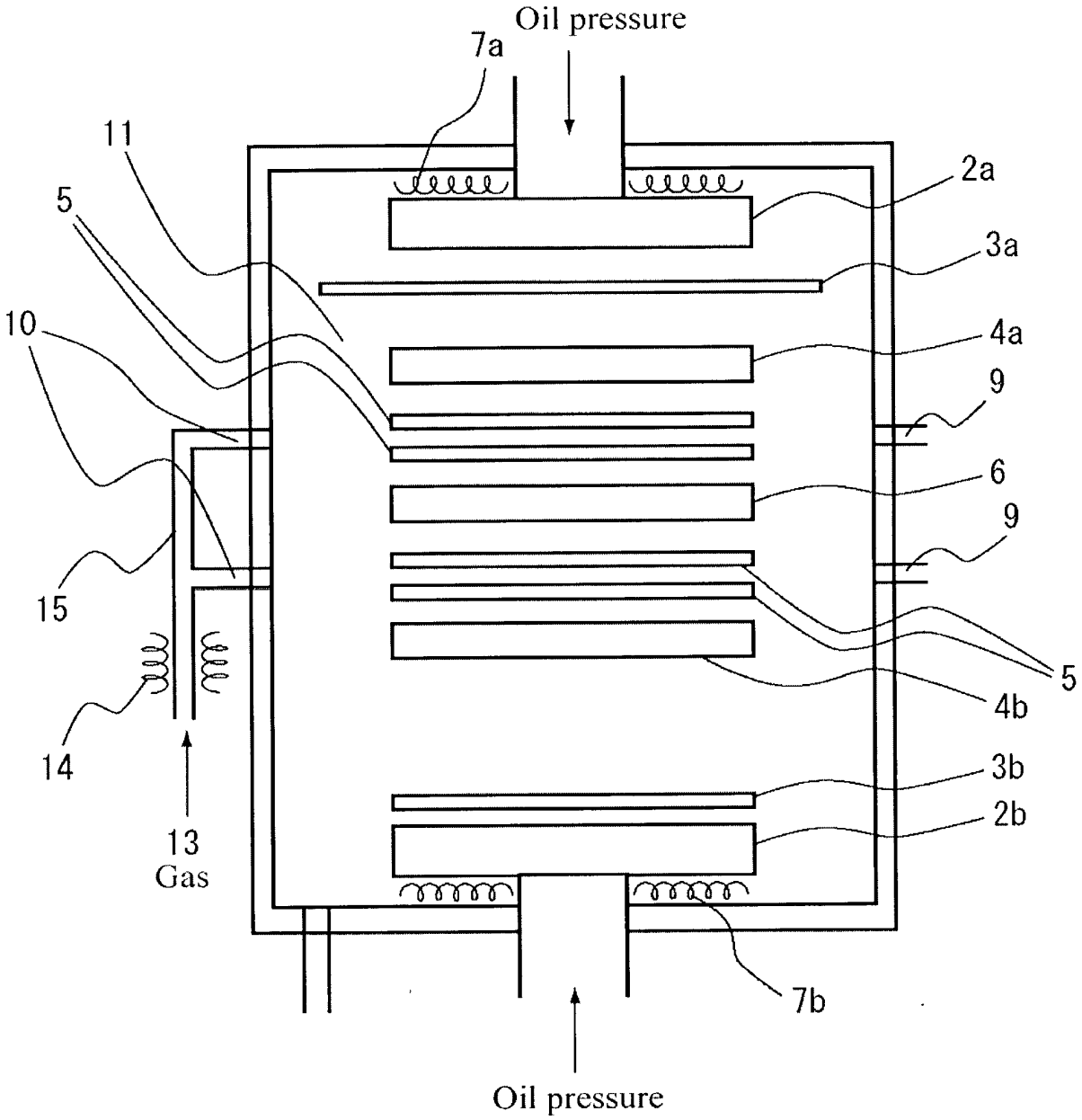
On the other hand, deformation and misregistration of through hole conductor were measured, and the misregistration was found to be 20 μm or less.

INDUSTRIAL APPLICABILITY

According to the present invention, a multilayered printed-circuit board exempt of exfoliation and swelling and presenting considerably less misregistration of through hole conductors than the prior art can be produced.

While this invention has been described as having a preferred design, the present invention can be further modified within the spirit and scope of this disclosure. This application is therefore intended to cover any variations, uses, or adaptations of the invention using its general principles. Further, this application is intended to cover such departures from the present disclosure as come within known or customary practice in the art to which this invention pertains and which fall within the limits of the appended claims.

FIG.1


Oil pressure
7a
11
5
2a
3a
10
4a
9
6
9
15
5
4b
14
3b
2b
13
Gas
7b
Oil pressure

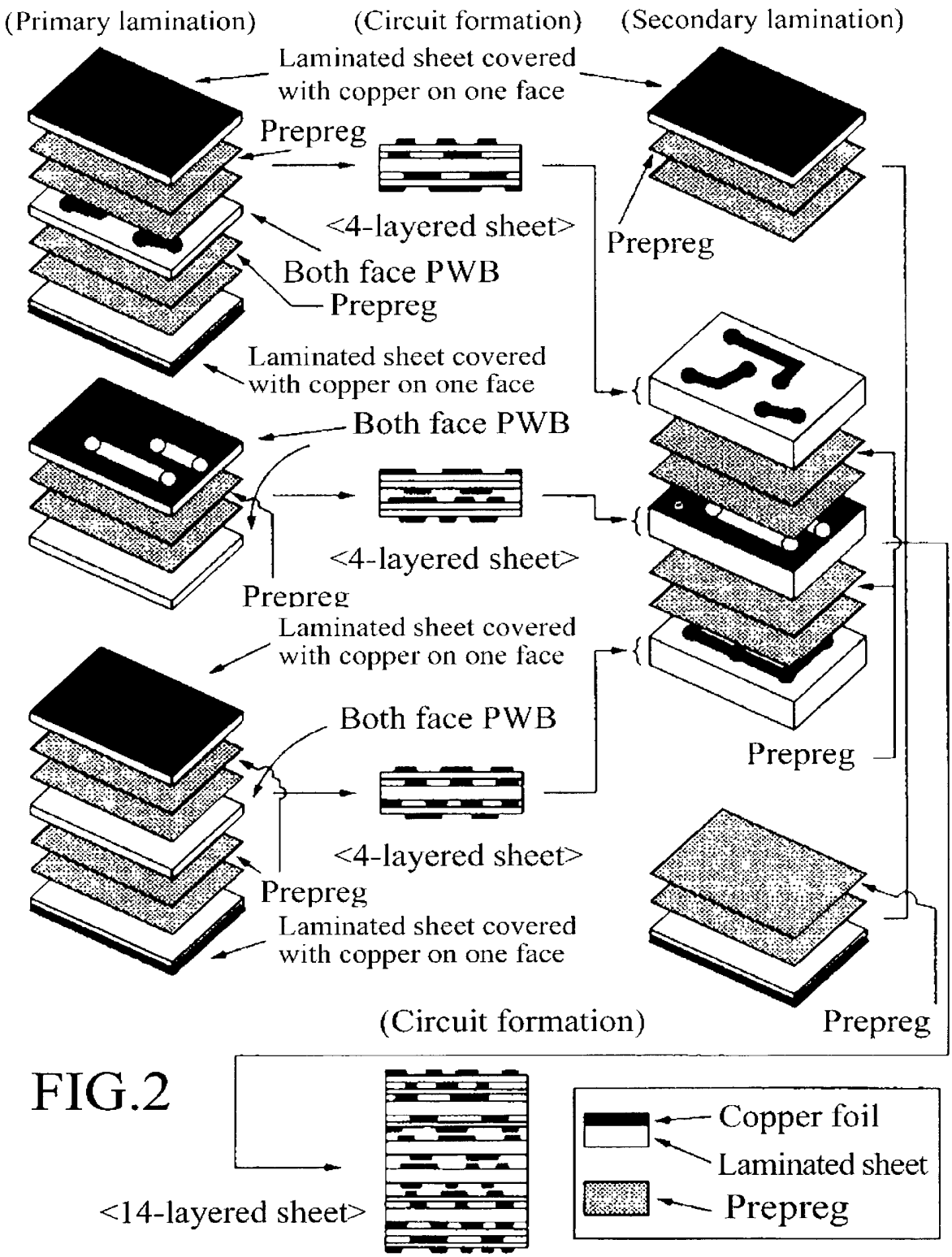
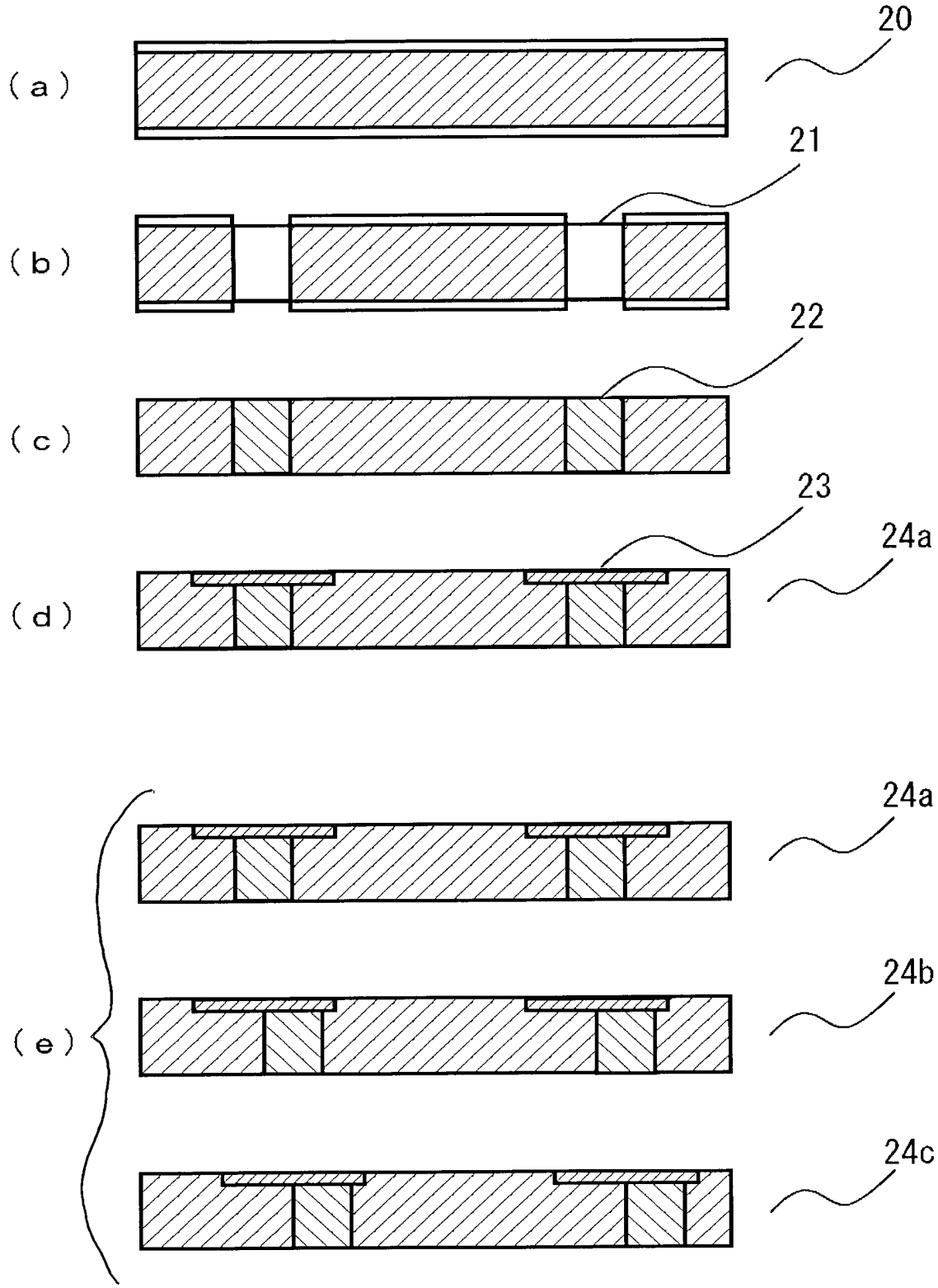

(Primary lamination)
(Circuit formation)
(Secondary lamination)
Laminated sheet covered with copper on one face
Prepreg
<4-layered sheet>
Both face PWB
Prepreg
Laminated sheet covered with copper on one face
Both face PWB
<4-layered sheet>
Prepreg
Laminated sheet covered with copper on one face
Both face PWB
<4-layered sheet>
Prepreg
Laminated sheet covered with copper on one face
Prepreg
Prepreg
(Circuit formation)
<14-layered sheet>
Copper foil
Laminated sheet
Prepreg

FIG.2

FIG.3



ATTORNEY'S DOCKET NO. FUK-89

PCT/USA NATIONAL DECLARATION AND POWER OF ATTORNEY
FOR U.S. PATENT APPLICATIONS
IN THE UNITED STATES PATENT AND TRADEMARK OFFICE
UNDER 35 U.S.C. SECTION 371(c)(4)

As a below named inventor, we hereby declare that:

Our residence, post office address and citizenship are as stated below next to my name:

I verily believe I am the original, first and sole inventor (if only one name is listed below) or a joint inventor (if plural inventors are named below) of the invention described and claimed in international application No. PCT/JP00/05393 entitled: PRODUCING METHOD OF MULTILAYERED PRINTED-CIRCUIT BOARD AND PRODUCING APPARATUS THEREOF and as amended on ___ (if any), which I have reviewed, and I understand the contents of the above identified specification, including the claims, as amended by any amendment referred to above and for which I solicit a patent; that I do not know and do not believe that this invention was ever known or used in the United States of America before my or our invention or discovery thereof, or patented or described in any printed publication in any country before my or our invention or discovery thereof, or more than one year prior to my international application; that this invention was not in public use or on sale in the United States of America for more than one year prior to my international application; that this invention has not been patented or made the subject of an inventor's certificate issued before the date of my international application in any country foreign to the United States of America on an application filed by me or my legal representatives or assigns more than twelve months before my international application; that I acknowledge my duty to disclose information of which I am aware which is material to the examination of this application; and that prior to filing said international application, applications for patent or inventor's certificate on this invention of discovery which have been filed by me or my legal representatives or assigns in any country foreign to the United States of America are as follows:

(a) none filed more than 12 months prior to said international application, unless named below:

(b) earliest filed less than 12 months prior to said international application (the priority of which is hereby claimed under 35 U.S.C. Section 365):

JP 11/229522 filed August 13, 1999

I hereby claim the benefit under Title 35, United States Code, §120, of any United States application(s) listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States application in the manner provided by the first paragraph of Title 35, United States Code, §112, I acknowledge the duty to disclose material information as defined in Title 37, Code of Federal Regulations, §1.56(a), which occurred between the filing date of the prior application and the national or PCT international filing date of this application.

(Application Serial No.)	(Filing Date)	(Status)(patented, pending, abandoned)

I hereby appoint Randall J. Knuth, Regis. No. 34,644, Victor F. Lohmann, III, Regis. No. 33,951 and Vincent P. Merz, Jr., Regis. No. 45,722 of the firm of RANDALL J. KNUTH, P.C., as attorney(s) to prosecute this application and transact all business in the Patent and Trademark Office connected therewith.

I declare further that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

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Inventor s Signature Tadahiro Ohmi Date Mar. 13, 2002

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ATTORNEY'S DOCKET NO. FUK-89

PCT/USA NATIONAL DECLARATION AND POWER OF ATTORNEY
FOR U.S. PATENT APPLICATIONS
IN THE UNITED STATES PATENT AND TRADEMARK OFFICE
UNDER 35 U.S.C. SECTION 371(c)(4)

As a below named inventor, we hereby declare that:

Our residence, post office address and citizenship are as stated below next to my name:

I verily believe I am the original, first and sole inventor (if only one name is listed below) or a joint inventor (if plural inventors are named below) of the invention described and claimed in international application No. PCT/JP00/05393 entitled: PRODUCING METHOD OF MULTILAYERED PRINTED-CIRCUIT BOARD AND PRODUCING APPARATUS THEREOF and as amended on ____ (if any), which I have reviewed, and I understand the contents of the above identified specification, including the claims, as amended by any amendment referred to above and for which I solicit a patent; that I do not know and do not believe that this invention was ever known or used in the United States of America before my or our invention or discovery thereof, or patented or described in any printed publication in any country before my or our invention or discovery thereof, or more than one year prior to my international application; that this invention was not in public use or on sale in the United States of America for more than one year prior to my international application; that this invention has not been patented or made the subject of an inventor's certificate issued before the date of my international application in any country foreign to the United States of America on an application filed by me or my legal representatives or assigns more than twelve months before my international application; that I acknowledge my duty to disclose information of which I am aware which is material to the examination of this application; and that prior to filing said international application, applications for patent or inventor's certificate on this invention of discovery which have been filed by me or my legal representatives or assigns in any country foreign to the United States of America are as follows:

(a) none filed more than 12 months prior to said international application, unless named below:

(b) earliest filed less than 12 months prior to said international application (the priority of which is hereby claimed under 35 U.S.C. Section 365):

JP 11/229522 filed August 13, 1999

I hereby claim the benefit under Title 35, United States Code, §120, of any United States application(s) listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States application in the manner provided by the first paragraph of Title 35, United States Code, §112, I acknowledge the duty to disclose material information as defined in Title 37, Code of Federal Regulations, §1.56(a), which occurred between the filing date of the prior application and the national or PCT international filing date of this application.

(Application Serial No.)	(Filing Date)	(Status)(patented, pending, abandoned)

I hereby appoint Randall J. Knuth, Regis. No. 34,644, Victor F. Lohmann, III, Regis. No. 33,951 and Vincent P. Merz, Jr., Regis. No. 45,722 of the firm of RANDALL J. KNUTH, P.C., as attorney(s) to prosecute this application and transact all business in the Patent and Trademark Office connected therewith.

I declare further that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

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[redacted]